V. *On the effects of simple pressure in producing that species of crystallization which forms two oppositely polarised images, and exhibits the complementary colours by polarised light.* By David Brewster, *LL.D. F.R.S. Edin. and F.S.A. Edin. In a letter addressed to the Right Hon. Sir* Joseph Banks, *Bart. K.B. P.R.S.*

Read January 19, 1815.

DEAR SIR,

IN prosecuting the experiments on the depolarisation of light, which you lately did me the honour to lay before the Royal Society, I have been led to the discovery of a remarkable property of soft transparent solids, in virtue of which they exhibit, by simple pressure, all the optical qualities of doubly polarising crystals. In the paper on depolarisation to which I have now alluded, it has been shown that a mixture of bees' wax and rosin, when melted and cooled between two plates of glass, depolarises a ray which falls upon it at a vertical incidence, while the same substance, pressed between two plates of glass, without the aid of heat, produces no effect when the polarised ray falls perpendicularly upon it, but depolarises it at an oblique incidence. In this experiment the crystallization was not produced by pressure, as the unmelted bees' wax was already crystallized; but it is obvious, either that the pressure had modified the natural crystallization of the bees' wax, so as to enable it to depolarise only at an oblique incidence, or that its liquefaction between two plates of glass had

produced such a change, as to communicate to it the property of perpendicular depolarisation.

In whatever manner this difference of action was produced, the effects of pressure seemed to require farther investigation, and in order to be able to apply a sufficient force, without injuring the structure of the substance, I employed animal jellies which could be brought to any degree of tenacity without losing their transparency.

Having cut out of newly made calves' feet jelly, a cylindrical portion, about half an inch broad and half an inch high, I placed it between two plates of glass, and observed that it did not possess, in the slightest degree, the property of depolarising light. After standing some days, it began to depolarise light at its circumference, and in the course of fifteen days this property gradually extended to its central parts. The cylinder of jelly had at first such a slight degree of tenacity, that it quivered with the gentlest motion; it was now however considerably indurated, and though it formed a plate exactly parallel, yet it diverged the incident rays like a concave lens, from the external parts having a greater degree of induration, and consequently a higher refractive power than the parts towards the centre. At the end of three weeks it began to lose its transparency, and at the same time its depolarising structure; and in the course of a few days more, it had no more action upon light than a mass of water. Its thickness was now reduced, by contraction, to about one-seventh of an inch, and it possessed a degree of tenacity, approaching to that of caoutchouc, which enabled it to sustain, without injury, a very considerable degree of pressure.

In this state, I exposed the plate of jelly to the light of a

candle polarised by reflection, and employing a prism of Iceland spar, one of the images of the candle vanished at every quadrant of its circular motion, just as if the jelly had not been interposed. I now pressed together the two plates of glass, that inclosed the cake of jelly, and was surprised to find that the vanished image was restored, the light being depolarised in every position of the cake. Upon removing the pressure, the image again vanished, and the cake resumed its uncrystallized state.

In order to vary the experiment, I took two prisms of Iceland spar, and having put them in such a position that two of the four images of a candle vanished; I then placed the cake of jelly between the prisms, and pressing them hard together, the two vanished images were restored, the depolarisation being more perfect as the pressure was increased. The removal of the pressure again destroyed the depolarising structure.

I repeated the preceding experiments with another plate of jelly, which was perfectly transparent, and which possessed the depolarising structure only at the edges. The pressure never failed to communicate to the central parts the property of depolarisation, and I repeatedly observed that the complementary colours produced by topaz, &c.* were imperfectly exhibited when the pressure had attained a particular magnitude.

As the cakes of jelly used in the preceding experiments, had both been crystallized by induration, I took another cylindrical portion that had never possessed that crystalline structure which is necessary to depolarise light. It was about an inch high, and three quarters of an inch broad, and was so

* See Phil. Trans. 1814. Part. I.

extremely soft that it could scarcely support itself in a vertical position. Having exposed it to a polarised ray, as before, I pressed its cylindrical circumference between my finger and thumb, and thus enabled it to restore the vanished image. A slight pressure, indeed, from one finger, was capable of producing a perceptible degree of depolarisation.

Instead of calves' feet jelly, I next employed *isinglass*, brought nearly to the consistency of caoutchouc. After standing a day, the isinglass had, of its own accord, acquired the depolarising structure, even when cut into very thin films, either parallel or perpendicular to the surface; but upon placing a cake of it, about a quarter of an inch thick, between two plates of glass, and exposing it to polarised light, I found that the complementary colours were developed in a most beautiful manner by hard pressure, and I often saw a portion of a red and a blue ring upon one of the images of the candle, while the colours complementary to these occupied the other image. By varying the pressure new colours arose, and when the pressure was removed, the complementary tints gradually disappeared. As these changes of colour might be ascribed to the pressure, only in so far as it reduced the cake of isinglass to the degree of thickness necessary for their production, I brought the cake to the same thickness which it possessed when exposed to the pressure that developed the most lively colours. No colours, however, were now visible, but they were instantly reproduced, as before, by the application of pressure.

I now melted the isinglass between two plates of glass, and allowed it to stand till it coagulated, which took place in less than a quarter of an hour. Upon transmitting through it a

polarised ray, I saw that it did not in the least degree depolarise it. I then exposed the included jelly to a considerable pressure, and it instantly restored the evanescent image, and exhibited, in a faint degree, the complementary colours. This plate was not more than $\frac{1}{20}$th of an inch thick.

From these experiments and others, which have been repeated under various modifications, it follows:

1st. *That soft animal substances which have no particular action upon light acquire, from simple pressure, that peculiar structure which enables them to form two images polarised in an opposite manner, like those produced by all doubly refracting crystals, and to exhibit the complementary colours produced by regularly crystallized minerals.*

2d *That soft animal substances, which already possess the property of depolarising light, receive from simple pressure such a modification in their structure as to enable them to exhibit, in a very brilliant manner, the complementary colours produced by crystallized minerals.*

3d. *That soft animal substances which only depolarise a portion of the incident ray, have their depolarising structure completed by simple pressure.*

The extension of these experiments to other soft substances, to hard bodies when in a fluid state, and to fluids themselves, may probably lead to still more interesting results.

I have the honour to be, Dear Sir,

your most obedient humble servant,

DAVID BREWSTER.

Edinburgh, January 3, 1815.

To the Right Hon. Sir JOSEPH BANKS, Bart. K. B. P. R. S.